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IS 8336 (1977): Thermoelectric Pyranometer [PGD 21: Meteorological Instruments]

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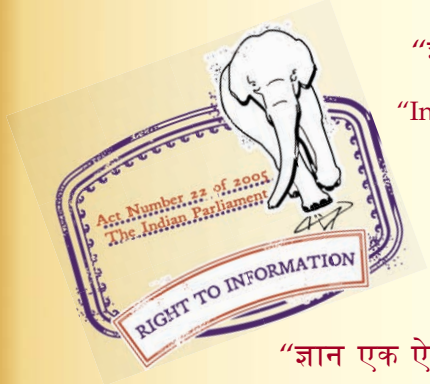

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IS : 8336 - 1977
(Reaffirmed 1990)

Indian Standard

SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

(First Reprint NOVEMBER 1990)

UDC 536·521·2 : 551·508·26

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3 *May* 1977

AMENDMENT NO. 4 AUGUST 2002
TO
IS 8336 : 1977 SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

(*Page* 10, *clause* **5.3.4**) — Insert the following new clause after **5.3.4**:

"5.4 Albedo is the ratio of reflected solar radiation to global solar radiation. Two pyranometers have to be used separately for the measurement of these two components of radiation.

For measurement of reflected radiation, a pyranometer has to be installed in such a way that the sensor faces the surface for which albedo has to be measured but does not affect or interfere with incoming solar radiations fall on the measured surface. The body of Pyranometer should be covered properly with some metallic hood painted white. It will protect the instrument from direct heating due to radiation falling on the body. This is essential because the massive metallic body of the pyranometer works as a sink for the thermo-junctions of the thermopile (sensor) which are in good heat contact with the body.

The Pyranometer with hood has to be installed about 1 to 2 m above the surface on an inverted 'L' shaped stand."

(BP 21)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 MAY 1994
TO
IS 8336 : 1977 SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

[*Page* 2, *clause* **0.2** (*see also Amendment No.* 1)] — Substitute the following for the existing:

'**0.2** Measurements of the total amount of energy received from the sun and sky are of fundamental importance in meteorology and in studies of the exchange and transformation of energy in the earth-atmosphere system and in biology, medicine, agriculture, architecture and industry. The solar radiation which reaches the earth's surface is contained in the range of wavelengths 0.3 to 4 μm (300 - 4 000 nm). The quantity of irradiance falling on unit area of the surface in unit time is expressed in Wm^{-2}. The solar constant, the solar irradiance received by a unit surface and placed normal to the irradiation just outside the earth's atmosphere at mean sun-earth distance has a value of 1369 7 Wm^{-2}.

[*Page* 7, *clause* **5.1.5** (*see also Amendment No.* 1)] — Substitute '± 3.0 Wm^{-2}' *for* '± 0.3 mW/cm^2' and '5 to 9 $\mu VW^{-1}m^{-1}$' *for* '8 mv/cal/ cm^2/min'.

(*Pages* 7 and 8, *clauses* **5.1.7**, **5.1.8**, **5.1.9**, **5.1.10**, **5.1.11**, **5.2.4** *and* **5.2.5**) — Substitute 'per cent' *for* 'percent'.

[*Page* 11, *clause* **7.1.2**(b) (*see also Amendment No.* 1)] — Substitute '$\mu vw^{-1}m^{-2}$' *for* 'mV/cal/cm^2/min'.

(LMD 21)

Reprography Unit, BIS, New Delhi, India

Indian Standard

SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

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Indian Standard

SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 28 January 1977, after the draft finalized by the Meteorological Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 Measurements of the total amount of energy received from the sun and sky are of fundamental importance in meteorology and in studies of the exchange and transformation of energy in the earth-atmosphere system and in biology, medicine, agriculture, architecture and industry. The solar radiation which reaches the earth's surface is contained in the range of wavelengths 0·3 to 4 μ (1 $\mu = 10^{-6}$m). The intensity of radiation is expressed as the amount of radiant energy falling on unit area of the surface in unit time and is expressed in mW/cm^2. The solar constant, the mean value of the intensity of solar radiation reaching a surface placed normal to the rays of the sun just outside the earth's atmosphere is assumed to be about 138·2 mW/cm^2.

0.3 The most widely used of the principal instruments for the measurement of solar radiation are those using the thermopile as the sensitive element, and used for the routine measurement of total incoming radiation of sun and sky, for the diffuse sky component and reflected solar radiation on a horizontal surface.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

---

1. SCOPE

1.1 This standard prescribes the requirements for a thermoelectric pyranometer and suitable recorders with charts for use with it.

*Rules for rounding off numerical values (*revised*).

2. DESCRIPTION

2.1 The thermopile consists of a series of copper-constantan thermo-junctions formed by winding constantan wire on a clear acrylic disc and plating half of each turn of the winding with copper. The junctions on the upper surface of the disc form the active or hot junctions while those on the lower form the cold junctions (*see* Fig. 1). The upper surface is covered with an aluminium foil which is electrically insulated from the junctions by a very thin layer of an epoxy resin cement, but is in good thermal contact with the active junctions. The passive or cold junctions are in good thermal contact with, but electrically insulated from, the massive base of the instrument. The active junctions exposed to radiation get heated while the passive junctions remain at ambient air temperature. By making the case massive and the outer surface painted matt white, the temperature is kept uniform. The sensitive surface, painted black by special optical black lacquer is protected by two concentric hemispherical glass domes, from wind and rain; they also reduce the tendency to form convection currents. The thermo-junctions, as a result of their difference in temperature, generate an electromotive force which is measured on a suitable millivoltmeter having the desired range and accuracy.

3. MATERIAL

3.1 The entire instrument shall be made of brass, unless otherwise specified.

3.2 The sensitive element shall be made of 0·19 mm thick constantan wire, part of which is plated with copper and wound over a clear acrylic disc as shown in Fig. 1.

3.3 The protective domes shall be made of special, optically clear flint glass.

3.4 The materials used throughout shall be resistant to the corrosive effects of damp air, specially near the sea.

4. DIMENSIONS

4.1 The instrument shall have the dimensions indicated in Table 1 read with Fig. 2 and 3.

5. DETAILED REQUIREMENTS

5.1 Pyranometer (*See* Fig. 3)

5.1.1 The glass domes shall be truly hemispherical in shape. They shall be made of special flint glass of exceptional clarity, uniform optical transmission characteristics and refractive index.

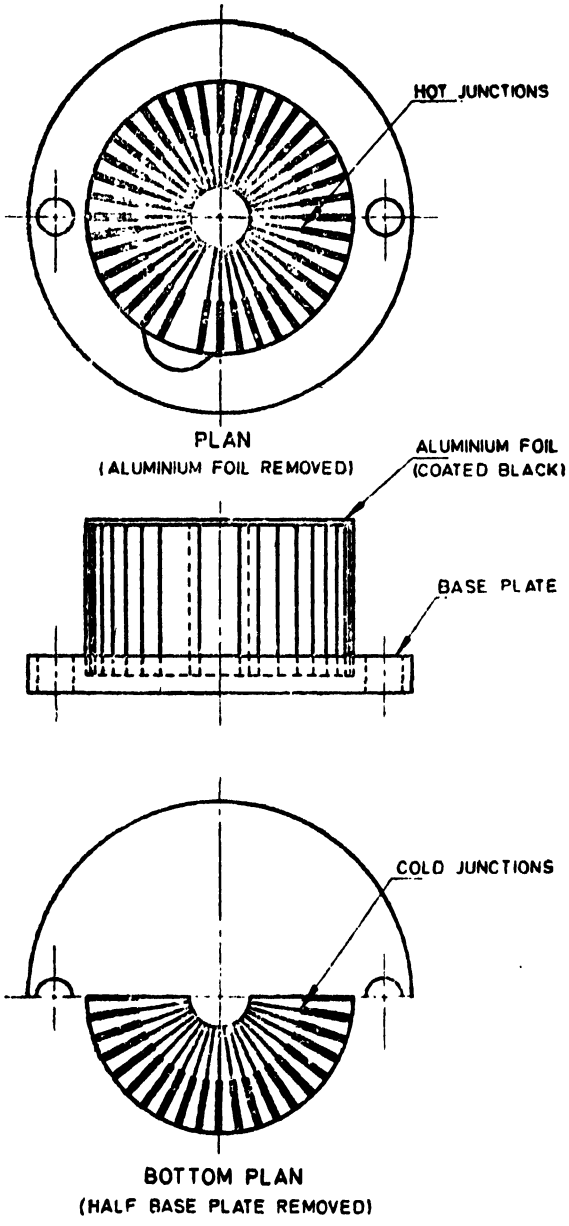
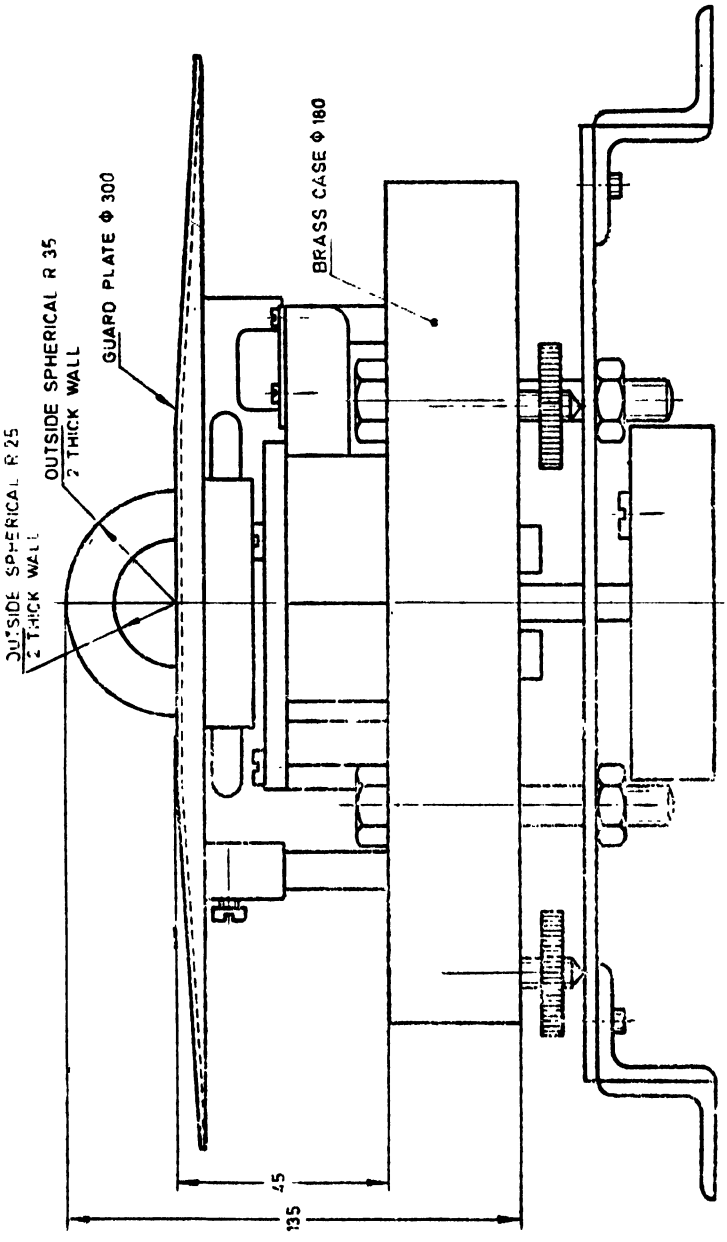


FIG. 1 THERMOPILE FOR THERMOELECTRIC PYRANOMETER



All dimensions in millimetres.

FIG. 2 DIMENSIONS FOR THERMOELECTRIC PYRANOMETER

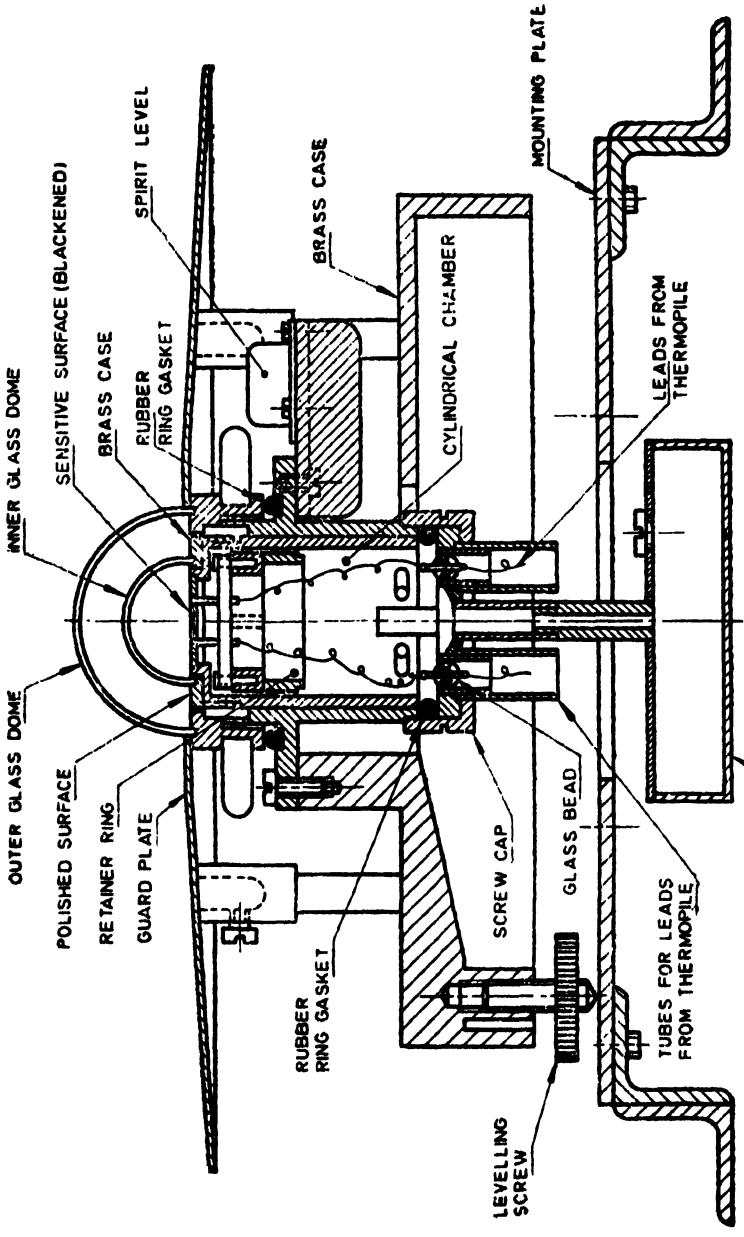


FIG. 3 SECTIONAL DETAIL OF THERMOELECTRIC PYRANOMETER

TABLE 1 DIMENSIONS OF PYRANOMETER

(*Clause* 4.1)

COMPONENT	DIMENSIONS mm
External diameter of outer glass dome	70
External diameter of inner glass dome	50
Thickness of the glass domes	2
Guard Plate	ϕ 300 × 1·5
Central hole in guard plate	75
Diameter of brass case	180
Overall height (without mounting plate)	135
Height of guard plate above mounting plate	90
Height of guard plate above brass case	45

5.1.2 The sensitive element shall consist of 39 active and passive copper constantan junctions formed on an insulating disc, approximately 20 mm in diameter and 8 mm thick. The thermopile should be made from 0·19 mm thick constantan wire.

5.1.3 The active junctions of the thermopile shall lie in an even horizontal plane and painted black with special optical black lacquer.

5.1.4 The absorptivity of the black lacquer shall not be less than 98 percent and uniform over a wide range of wavelengths.

5.1.5 The sensitivity of the instrument, that is, the smallest change in the quantity being measured which may be detected by it, shall be $\pm 0{\cdot}3$ mW/cm^2 and the output 8 mV/cal/cm^2/min, the total resistance with the connecting leads being 15 ohms.

5.1.6 The stability of the calibration factor, that is, the maximum permissible change in this factor percent per year shall not exceed ± 2.

5.1.7 The maximum error due to variation in ambient temperature shall not exceed $-0{\cdot}2$ percent per °C.

5.1.8 The maximum error caused by a departure from the assumed spectral response of the receiving surface shall not exceed ± 1 percent.

5.1.9 The maximum error due to non-linearity of the response of the instrument shall not exceed ± 1 percent.

5.1.10 The time constant of the instrument, that is, the time necessary for it to register 98 percent of a sudden change in radiation shall not exceed 30 seconds.

5.1.11 The consine response and the azimuth response, that is, the deviation of the directional response of the receiver from that assumed shall be within ± 3 percent.

5.1.12 The entire instrument, except for the two glass domes, shall be protected from direct radiation by mounting it in the centre of a circular guard plate, 300 mm in diameter and painted white. The top surface of the guard plate shall be exactly level with the blackened surface of the thermopile for a distance of 25 mm from the inner edge and shall slope down from there at an angle of about 10°.

5.1.13 The electrical leads from the thermopile shall be mounted air-tight inside the tubes through which they emerge and the screw cap closing the bottom lid of the cylindrical chamber shall be threaded over a rubber ring washer. The interior of the cylindrical chamber shall be connected to a vessel containing a dehydrating agent like silica gel such that the chamber is air tight and dry at all times.

5.1.14 The entire instrument shall be mounted over a mounting plate approximately $210 \times 210 \times 5$ mm also painted white. The mounting plate shall be provided with a number of small holes of 10 mm diameter drilled on the periphery of a circle of diameter approximately 105 mm for ease of installation and correct alignment.

5.2 Recorder

5.2.1 The recorder shall be of the potentiometric type and be provided with an arrangement which gives a continuous record on a roll chart.

5.2.2 The method of recording shall be through a capillary pen writing with ink on paper.

5.2.3 The chart drive of the recorder shall be operated by an electrically driven motor. The chart speed shall be at least 25 mm/h. Provision shall be made for varying the chart speed up to 150 mm/h.

5.2.4 The recorder shall have a range of 0 to 15 mV and an accuracy of $\pm$ 1 percent. It shall have a threshold sensitivity of $\pm 0{\cdot}1$ percent.

5.2.5 The measuring circuit of the recorder shall have the temperature coefficient as near to zero as possible and the total errors of the recording apparatus shall not exceed ± 1 percent.

5.3 Recorder Chart

5.3.1 The chart shall be of the roll type indicated in Fig. 4 and designated RP 1.

5.3.2 It shall have a minimum length of 30 m and a minimum width of 160 mm in the graduated portion. The overall width of the roll chart shall be not less than 180 mm.

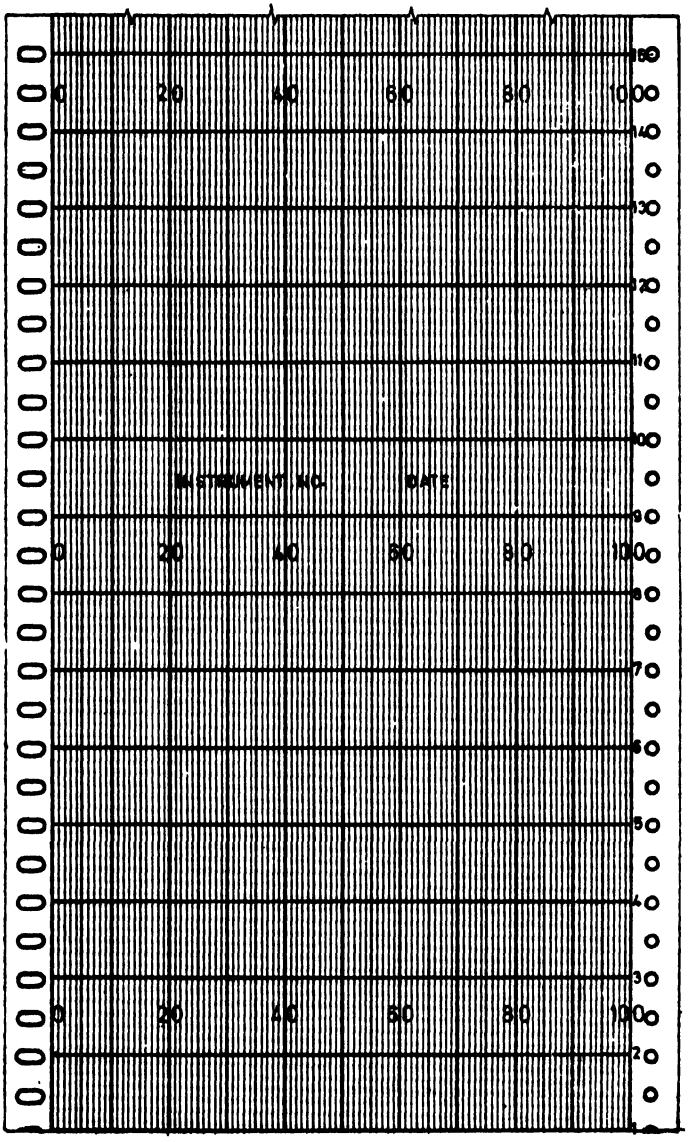


FIG. 4 RECORDER CHART NO. RP1

5.3.3 It shall be divided along its width into at least 100 arbitrary equal divisions with every fifth division slightly thickened and every tenth division more prominently thickened. It shall have printed on it vertical lines corresponding to hours, the time scale being equal to at least 25 mm/h. Each hour line shall appropriately be figured. The arbitrary lines shall be figured at intervals of 20 divisions, the set of figures being spaced 200 mm apart.

5.3.4 The chart shall be printed on thin white paper on which the recording ink shall not spread or show tendency to feather.

6. WORKMANSHIP AND FINISH

6.1 The glass domes of the pyranometer shall be absolutely clear, clean and well polished.

6.2 The complete instrument in the final stage of assembly shall satisfy the requirements laid down for it in **5.1**.

6.3 Special care shall be given to make the interior of the instrument air-tight and dry to ensure longivity and sensitivity of the sensing element. It shall be ensured that moisture does not reach the leads from the thermopile.

6.4 The connections of the wires shall be made neatly using minimum amount of solder while at the same time ensuring strength and permanance of contact. The electrical junctions shall be suitably protected by glass fibre sleevings and wax coating to prevent malfunctioning of the electrical circuit due to high humidity and presence of water vapour.

6.5 The entire instrument except the glass domes and the thermopile shall be painted white with two coats of good quality enamel paint over a coat of primer.

6.6 The top surface of the instrument case between the two glass domes shall be highly polished to reduce the absorption of radiation. The levelling screws shall be nickel plated.

7. MARKING AND PACKING

7.1 Marking

7.1.1 Each pyranometer shall have the following neatly and legibly engraved on a plate fixed to the brass case.

a) Thermoelectric pyranometer;

b) The manufacturer's name or trade-mark, if any; and

c) The serial number and year of manufacture.

7.1.2 The complete equipment shall also be provided with a card giving the following information:

a) The resistance of the thermopile,

b) The output of the pyranometer in mV/cal/cm²/min, and

c) Range and accuracy of the potentiometric recorder.

7.1.3 The instrument may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

7.2 Packing — The pyranometer and the recorder shall be suitably packed separately as agreed to between the purchaser and the manufacturer. Each instrument set shall be supplied with sufficient quantity of suitable charts wrapped in waterproof paper to last about 12 months.

8. INSPECTION

8.1 Each pyranometer and recorder with charts shall be inspected individually for conformity to all the requirements of this specification.

INDIAN STANDARDS
ON
METEOROLOGICAL INSTRUMENTS

IS:

4849-1968 Rain measures

5225-1969 Raingauge, non-recording

5235-1969 Raingauge, recording

5798-1970 Aneroid barometers

5798-1970 Mercury barometers

5799-1970 Windvane

5900-1970 Hair hygrograph

5901-1970 Thermograph, bimetallic

5912-1970 Anemometer, cup counter

5924-1970 Clock mechanisms and drums for meteorological instruments

5945-1970 Barograph, aneroid

5946-1970 Whirling psychrometer

5947-1970 Charts for recording meteorological instruments

5948-1970 Thermometer screens

5973-1970 Pan evaporimeter

6805-1973 Assmann psychrometer

6806-1973 Snowgauge

6871-1973 Distant indicating wind equipment

7243-1974 Sunshine recorder

7244-1974 Thermometer for mercury barometer

8336-1977 Thermoelectric pyranometer

AMENDMENT NO. 1 NOVEMBER 1985

TO

IS:8336-1977 SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

(*Page 2, clause 0.2*) - Substitute the following for the existing clause:

'0.2 Measurements of the total amount of energy received from the sun and sky are of fundamental importance in meteorology and in studies of the exchange and transformation of energy in the earth-atmosphere system and in biology, medicine, agriculture, architecture and industry. The solar radiation which reaches the earth's surface is contained in the range of wavelengths 300 to 400 mm. The quantity of radiation is expressed as the amount of radiant energy falling on unit area of the surface in unit time and is expressed in W_m^{-2}.

The solar constant, the mean value of the quantity of solar radiation reaching a surface placed normal to the rays of the sun just outside the earth's atmosphere at mean sun-earth distance is assured to be about $1\ 367 \pm 7\ W_m^{-2}$.'

(*Page 2, clause 0.3, line 3*) - Delete the word 'total'.

(*Page 5, Fig. 2*) - Substitute 'R 25' *for* 'R 35' and 'R 15' *for* 'R 25'.

(*Page 7, Table 1, under 'Dimensions'*) - Substitute '50' *for* '70, '30' *for* '50' and '55' *for* '75'.

(*Page 7, clause 5.1.5, line 3*) - Substitute '$\pm\ W_m^{-2}$' *for* '$\pm$ 0.3 m W/cm^2' and '11 to 12 $\mu V/W_m^{-2}$' *for* '8 mV/cal/cm^2/min'.

(*Page 8, clause 5.1.14*) - Add the following sentence at the end:

'The mounting plate can also be made out of anodised (white) aluminium.'

(*Page 8, clause 5.2.3, line 2*) - Substitute '30 mm/h or 60 mm/h' *for* '25 mm/h'.

(*Page 8, clause 5.3.2*) - Substitute the following for the existing clause:

'5.3.2 It shall have a minimum length of 30 m and a minimum width of 110 mm in the graduated portion. The overall width of the roll chart shall not be less than 130 mm, charts with 250 mm graduated portion are also acceptable.'

(*Page 10, clause 5.3.3, line 4*) - Substitute '30 mm/h' *for* '25 mm/h'.

[*Page 11, clause 7.1.2*(b)] - Substitute '$\mu V/W_m^{-2}$' *for* '$mV/cal/cm^2/min$'.

(EDC 69)

Printed at Dee Kay Printers, New Delhi, India

AMENDMENT NO. 2 JANUARY 1987

TO

IS:8336-1977 SPECIFICATION FOR THERMOELECTRIC PYRANOMETER

(*Page 10, clause 5.3.3, line 1*) - Delete the word 'arbitrary'.

(EDC 69)

Reprography Unit, ISI, New Delhi, India

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